

# SCIENCE

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## WHAT AMERICAN ZOÖLOGISTS HAVE DONE FOR EVOLUTION.<sup>1</sup>

LADIES AND GENTLEMEN, — Eleven years ago I had the honor of reading before this association an address in which an attempt was made to show what American zoölogists had done for evolution. My reasons for selecting this subject were, first, that no general review of this nature had been made; and, second, that many of the oft-repeated examples in support of the derivative theory were from European sources, and did not carry the weight of equally important facts the records of which were concealed in our own scientific journals. Darwin was pleased to write to me that most of the facts I had mentioned were familiar to him, but, to use his own words, he was amazed at their number and importance when brought together in this manner. The encouragement of his recognition has led me to select a continuation of this theme as a subject for the customary presidential address, — a task which is at best a thankless if not a profitless one. Had I faintly realized, however, the increasing number and importance of the contributions made by our students on this subject, I should certainly have chosen a different theme.

Incomplete as is this record of ten years' work, I am compelled to present it. In the Buffalo address two marked periods in the work of the zoölogists in this country are recognized: the one period embracing the work of the topographers, the field-surveyors in the science; the other period dating from the advent of Agassiz, with the wonderful impulse he imparted to the study by his enthusiasm and devotion. A third period in American zoölogical science, and by far the most important awakening, dates from the publication of Darwin's 'Origin of Species.' Its effect on zoölogical literature was striking. The papers were first tinged with the new doctrine, then saturated, and now, without reference to the theory, derivation is taken for granted.

As zoölogists, we are indebted to Darwin for the wide-spread public interest in our work. Before Darwin, the importance of our special studies was far outweighed by the practical value placed upon science, in the application of which an immediate material gain was assured. Chemistry, physics, geology, were important only because a practical application of these sciences was capable of showing an immediate material return.

Agassiz, in his appeal to the State for appropriations for the great museum at Cambridge, insisted that there were higher dividends than money ones to be looked for in endowments for zoölogical museums, and these were intellectual dividends. While the force of this appeal will always remain true, the transcendent importance of the naturalist's studies from the standpoint of Darwin is widely recognized. Man now becomes an object of rigid scientific scrutiny, from the new position which has shed such a flood of light upon the animals below him. His habits, behavior, the physical influences of his environment and their effects upon him, transmission of peculiarities, through the laws of heredity, — all these factors are directly implicated in the burning questions and problems which agitate him to-day. Questions of labor, temperance, prison-reform, distribution of charities, religious agitations, are questions immediately concerning the mammal man, and are now to be seriously studied from the solid standpoint of observation and experiment, and not from the emotional and often incongruous attitude of the Church. To a naturalist it may seem well-nigh profitless to discuss the question of evolution, since the battle has been won; and, if there be any discussion, it is as to the relative merits and force of

the various factors involved. The public, however, are greatly interested in the matter, as may be seen by a renewal of the fight in the English reviews; and the agitation is still kept up by well-meaning though ignorant advisers, who insist that science has not yet accepted the doctrine; and great church organizations meet to condemn and expel their teachers of science from certain schools of learning because their teachings are imbued with the heresy.

Dr. Asa Gray, in his discriminating biographical memoir of Darwin, says in regard to the 'doctrine of descent,' "It is an advance from which it is evidently impossible to recede: as has been said of the theory of the conservation of energy, so in this the proof of this great generalization, like that of all other great generalizations, lies mainly in the fact that the evidence in its favor is continually augmenting, while that against it is continually diminishing as the progress of science reveals to us more and more the workings of the universe." Let us examine, then, the evidences, trivial as well as important, that have been recorded by American zoölogists within the past ten years in support of the derivative theory.

Without further apology for the very imperfect character of this survey, let me at once begin by calling attention first to the testimony regarding the variation in habits, and evidences of reasoning-power, in animals. The establishment of individual variation in mental powers, change in habits, etc., lies at the foundation of Darwinism as furnishing material for selective action. There is no group of animals which exceeds the birds in varied and suggestive material for the evolutionist. It is a significant fact that the birds, which appeared to Cuvier and his contemporaries a closed type, — a group that seemed to fulfil the ideal conception of a class archetype as compared to other groups which had their open as well as obscure relationships, — should be, of all groups, the one that first yielded its exclusive characteristics. In fact, there is no group in which the barriers have been so completely demolished as in this apparently distinct and isolated class. An attentive and patient study of the birds has established almost every point defined by Darwin in his theory of natural selection. One has only to recall the marked reptilian affinities as shown in their embryological and paleontological history. Besides all these structural relationships, the birds possess, as a group, remarkable and striking illustrations of variation in color, size, marking, nesting, albinism, melanism, moulting, migration, song, geographical variation, sexual selection, secondary sexual characters, protective coloring; and in their habits show surprising mechanical cunning and ingenuity, curious and inexplicable freaks, parental affection, hybridity: indeed, the student need go no further than the birds to establish every principle of the derivative theory.

The many observations on the nesting habits of birds would form a curious chapter as illustrating the individual peculiarities of these creatures.

Mr. J. A. Allen, in writing on the inadequate theory of bird's-nests, shows grave and important exceptions to Wallace's theory, though he subscribes heartily to his philosophy of bird's-nests. He expresses surprise that closely allied species of birds should oftentimes build divers kinds of nests, overlooking the fact that even closely allied varieties of man build entirely unlike houses.

The behavior of wild birds when kept in confinement, and the attempts made in domesticating them, has always furnished an interesting field for study. The curious freaks and impulses which they often betray, the changes they show under the new conditions, indicate in some measure the plasticity of their organization.

Hon. John D. Caton, in an interesting paper on unnatural attachments among animals, records a curious fondness shown by a crane for a number of pigs; and in another paper on the wild turkey and its domestication, this writer has made some valuable records

<sup>1</sup> Abridged from the address to the American Association for the Advancement of Science, at New York, Aug. 10, 1887, by Prof. E. W. Morse of Salem, Mass., the retiring president of the association.

of the successive changes which take place in the bird during this process, — changes in color, during which the more conspicuous features of protective coloring are lost; changes in habit, in which are seen the undoing or relaxing of those features which indicate constant vigilance, from carrying itself in a semi-erect attitude, perching on the tallest trees, covering up the eggs carefully with leaves when off the nest, etc., to moving in a horizontal attitude, perching near the ground, covering the eggs but slightly or carelessly, etc., and losing that wildness which characterizes the bird in its wild state. At the breeding-season, however, the females became wild again, but this was a feature too deeply implanted to show modification in the time allotted to Mr. Caton's experiment. The same writer has also observed in the Hawaiian Islands the effects of reversion to a wild state, of different kinds of domestic animals which have from time to time been carried there. Among other animals, he was fortunate enough to observe the undoing stages in the domestic turkey, and the assumption of those features which characterize the wild bird.

A great many facts illustrating the plainest features of natural selection, protective coloring, mimicry, etc., have been recorded in our journals from time to time. A brief allusion may be made to a few of these. . . . Dr. R. E. C. Stearns has made some interesting notes on protective coloring in *Phrynosoma*. Having collected these horned lizards (or toads, as they are commonly called) in central California, he has noticed, that, if the ground region they frequent is yellowish, the lizards are, without exception, of that color; if ashen gray, then that color is simulated; and this, without exception.

An unquestionable fact has been finally established by recent methods of observation on the habits of insects and other animals, and that is, that individuals of the same species vary in intelligence; that they are not automata; that they are not impelled by a blind instinct to perform certain acts with unerring accuracy, but, on the contrary, that they vary, and often greatly vary, in their ability to provide for their young, in their skill to secure sufficient food, in their wit to avoid danger: in other words, they make blunders and mistakes, and involve their progeny and even their colony in ruin. This individual variation in intelligence is brought out very clearly by a patient series of observations made by Drs. G. W. and E. G. Peckham on the special senses of wasps. They not only repeated many of the experiments of Sir John Lubbock, but many new and ingenious experiments were devised. Their studies were for the purpose of investigating the mental power, sense of hearing, color, direction, memory, emotion, power of communication, general intelligence, etc. An interesting result of their painstaking work was the determination of individual differences as to the faculty of memory and power of distinguishing color and direction. This kind of study of the habits of insects has brought to light features of the most surprising character. The remarkable studies of Sir John Lubbock, Dr. Moggridge, and others in Europe, have been paralleled in this country not only by the observations above quoted, but notably by the labors of Rev. H. C. McCook in his studies of the American ants and spiders.

Dr. Thomas Meehan describes a hornet that was gifted with great intelligence. He saw this insect struggling with a large locust in unsuccessful attempts to fly away with it. After several fruitless efforts to fly up from the ground with his victim, he finally dragged it fully thirty feet to a tree, to the top of which he laboriously ascended, still clinging to his burden, and, having attained this elevated position, he flew off in a horizontal direction with the locust. Dr. Meehan truly says, "There was more than instinct in this act: there was reasoning on certain facts, and judgment accordingly, and the insect's judgment had proved correct."

The delicate balance of conditions between organisms, whether it be between individuals of the same species or between widely separated groups, is an important feature in the question of survival. Prof. S. A. Forbes, in a thoughtful study of certain species of *Entomostraca* in Lake Michigan and the surrounding waters, calls attention to the important part played by these minute crus-

taceans, showing how they furnish almost the entire food for young fishes, larger crustaceans, and even insect larvæ. He writes, "*Mollusca*, one would say, could afford to be indifferent to them, since they neither eat them nor are eaten by them, nor seem to come in contact with them anywhere, through any of their habits or necessities. But for this very reason these two classes afford an excellent illustration of the stringent system of re-actions by which an assemblage of even the most diverse and seemingly independent organisms is held together. . . . If there were no *Entomostraca* for young fishes to eat, there would be very few fishes indeed to feed upon *Mollusca*, and that class would flourish almost without restraint; while, on the other hand, if there were no *Mollusca* for the support of adult fishes, *Entomostraca* would be relieved from a considerable part of the drain upon their numbers, and would multiply accordingly." He is much struck with the fact that in the larger bodies of water the species of *Entomostraca* show an inferior development in numbers, size, and robustness, and in reproductive power. Their smaller number and size are doubtless due to the relative scarcity of food.

The effect of mechanical strains as producing morphological effects has been treated in a masterly way by Dr. John A. Ryder. . . . Prof. A. Hyatt, in an exhaustive study, shows, among other things, the effect of gravitation as accounting for the form of the mollusk-shell, citing examples from all the classes, and even drawing examples from other sub-kingdoms, to support his views.

Prof. E. D. Cope, in a memoir on archæstheticism, considers the hypothesis of use and effort, the office of consciousness, etc. He attempts to show that consciousness is primitive, and a cause of evolution. He sustains his thesis by a series of arguments, which, if not beyond my grasp, would be too extensive to present here. I can only repeat the regret I expressed in the Buffalo address; namely, that neither Professor Cope nor Professor Hyatt have yet been induced to present to the public an illustrated and simple outline of their theories. Such a demonstration, I am sure, would be acceptable not only to the public, but to many scientific students as well. While these two eminent naturalists believe fully in the derivative theory, they insist that Darwin's theory is inadequate to explain many of the phenomena and facts which they encounter in their studies. Darwin has distinctly said in his first edition of the 'Origin of Species,' "I am convinced that natural selection has been the main but not the exclusive means of modification;" and in his sixth edition of the same work, in quoting these words, he laments that he is still misunderstood on this point. The theory of acceleration and retardation of these authors is, if I understand it rightly, a very plain case of natural selection. It was inevitable that those individuals that matured the quickest were better prepared to defend themselves, were quicker in the field, were able to give their offspring an earlier start in the season, were in every way more fitted to survive, than those which matured later. It is assumed that this is a law, when, to my mind, it seems the simplest result of natural selection. Instead of overriding it, it is only a conspicuous result and proof of it.

A parallel case may be seen in the increase in size of the brain in the vertebrates, and conspicuously in the higher vertebrates, since their first appearance in geological history. The individual brain clearly varies in size; and it does not require a great effort to perceive how, in the long-run, the greater brain survives in the complex struggle for existence. Associated with the greater development, parts that were freely used for locomotion before, now are compelled to perform additional service, and through the law of use and effort, which all admit as an important factor, organs are modified in structure, the anterior portion of the body assumes a new aspect; and it was on the character of these parts and aspects that Professor Dana was led to formulate his comprehensive and ingenious principle of cephalization. It is a result, and not a cause. And so I believe, though with great deference to Cope and Hyatt, that the laws of acceleration and retardation, exact parallelisms, inexact parallelisms and still more inexact parallelisms, and many other laws and theories advanced by these gentlemen, are not causes, but effects, to be explained by the doctrine of natural selection and 'survival of the fittest.'

The connecting links and intermediate forms which the sceptical

public so hungrily demand are continually being discovered. Great gaps are being closed up rapidly; but the records of this work, being published in the journals of our scientific societies, are hidden from the public eye as much as if they had been published in Coptic. So rapidly have these missing links been established, that the general zoölogist finds it difficult to keep up with the progress made in this direction. He can hardly realize the completion of so many branches of the genealogical tree.

Professor Cope, who has accomplished so much in this direction, says, "Those who have, during the last ten years, devoted themselves to this study, have been rewarded by the discovery of the course of development of many lines of animals; so that it is now possible to show the kind of changes in structure which have resulted in the species of animals with which we are familiar as living on the surface of the earth at the present time. Not that this continent has given us the parentage of all forms of animal life, or all forms of animals with skeletons, or vertebræ, but it has given us many of them. To take the *Vertebrata*, we have obtained the long-since extinct ancestor of the very lowest vertebrates. Then we have discovered the ancestor of the true fishes. We have the ancestor of all the reptiles, of the birds, and of the mammals. If we consider the mammals, or milk-givers, separately, we have traced up a great many lines to their points of departure from very primitive things. Thus we have obtained the genealogical trees of the deer, the camels, the musk, the horse, the tapir, and the rhinoceros, of the cats and dogs, of the lemurs and monkeys, and have important evidence as to the origin of man."

The discovery in the western tertiaries of multitudes of huge and monstrous mammals, and, earlier still, of gigantic and equally monstrous reptiles, naturally led at once to an inquiry as to the cause of their extinction. . . . Among the most interesting discoveries connected with these creatures is the determination by Professor Marsh that these early mammals, birds, and reptiles had brains of diminutive proportions. . . . "The small brain, highly specialized characters, and huge bulk, rendered them incapable of adapting themselves to new conditions, and a change of surroundings brought extinction. The existing proboscideans must soon disappear for similar reasons. Smaller mammals, with larger brains, and more plastic structure, readily adapt themselves to their environment, and survive, or even send off new and vigorous lines. The *Dinocerata*, with their very diminutive brain, fixed characters, and massive frames, flourished as long as the conditions were especially favorable, but with the first geological change they perished and left no descendants."

Prof. A. E. Verrill, in a lecture at Yale College entitled 'Facts Illustrative of the Darwinian Theory,' shows what an important factor parental instinct is in the evolution of species. He regards the lack of parental care "as one of the probable causes, though usually overlooked, of the extinction of many of the large and powerful reptiles of the mesozoic age, and of the large mammals of the tertiary." He says, "The very small size of the brain, and its low organization, in these early animals, are now well known, and we are justified in believing that their intelligence or sagacity was correspondingly low. They were doubtless stupid and sluggish in their habits, but probably had great powers of active and passive resistance against correspondingly stupid carnivorous species. But, unless the helpless young were protected by their parents, they would quickly have been destroyed; and such species might, in this way, have been rapidly exterminated whenever they came in contact with new forms of carnivorous animals, having the instinct to destroy the new-born young of mammals, and the eggs and young of oviparous reptiles. Thus it would have come about, that the more intelligent forms, by the development of the parental instinct for the active protection of their young against their enemies, would have survived longest, and therefore would have transmitted this instinct, with other correlated cerebral developments, to their descendants."

Prof. John Fiske, in his 'Cosmic Philosophy,' arrived at a similar conclusion in regard to early man. He showed, that, when variations in intelligence became more important than variations in physi-

cal structure, then they were seized upon to the relative exclusion of the latter.

The wide-spread public interest in Darwinism arose from the fact that every theory and every fact advanced in proof of the derivative origin of species applied with equal force to the origin of man as one of the species. The public interest has been continually excited by the consistent energy with which the Church, Catholic and Protestant alike, has inveighed against the dangerous teachings of Darwin. Judging by centuries of experience, as attested by unimpeachable historical records, it is safe enough for an intelligent man, even if he knows nothing about the facts, to promptly accept as truth any generalization of science which the Church declares to be false, and, conversely, to repudiate with equal promptness, as false, any interpretation of the behavior of the universe which the Church adjudges to be true. In proof of this sweeping statement, one has only to read the imposing collection of facts brought together by Dr. White, the distinguished president of Cornell University, which are embodied in his work entitled 'The Warfare of Science,' as well as two additional chapters on the same subject which have lately appeared in the *Popular Science Monthly*.

Only the briefest reference can here be made to a few of the numerous contributions on the subject of man's relationship to the animals below him. The rapidly accumulating proofs of the close relation existing between man and the *Quadrumana* make interesting every fact, however trivial, in regard to the structure and habits of the higher apes.

Dr. Arthur E. Brown has made some interesting experiments with the monkeys at the Zoölogical Gardens in Philadelphia. He found that the monkeys showed great fear, as well as curiosity, when a snake was placed in their cage, though they were not affected by other animals, such as an alligator and turtle. On the other hand, mammals belonging to other orders showed no fear or curiosity at a snake. These experiments, repeated in various ways, lead him to only one logical conclusion,—"that the fear of the serpent became instinctive in some far-distant progenitor of man by reason of his long exposure to danger, and death in horrible form from the bite, and it has been handed down through the diverging lines of descent which find expression to-day in the genus *Homo* and *Pithecius*."

The same author, in an exceedingly interesting description of the higher apes, says, "Mr. A. R. Wallace once called attention to the similarity in color existing between the orang and chimpanzee and the human natives of their respective countries. It would, indeed, seem as if but half the truth had been told, and that the comparison might be carried also into the region of mind; the quick, vivacious chimpanzee partaking of the mercurial disposition of negro races, while the apathetic slow orang would pass for a disciple of the sullen fatalism of the Malay."

Dr. Brown has also given a description of the grief manifested by a chimpanzee on the death of its mate. His grief was shown by tearing his hair or snatching at the short hair on his head. The yell of rage was followed by a cry the keeper had never heard before,—a sound which might be represented by 'hah-ah-ah-ah' uttered somewhat under the breath,—and with a plaintive sound like a moan.

Mr. W. F. Hornaday read at the Saratoga meeting of this association an exceedingly interesting paper on the habits of the orang as observed by him in its native forests. He says, "Each individual of the Borneo orangs differs from his fellows, and has as many facial peculiarities belonging to himself alone as can be found in the individuals of any unmixed race of human beings." After recounting the many traits of the orang, heretofore regarded as peculiar to man, he says, "Let any one who is prejudiced against Darwinian views go to the forests of Borneo; let him there watch from day to day this strangely human form in all its various phases of existence; let him see it climb, walk, build its nest, eat and drink, and fight like human 'roughs'; let him see the female suckle her young and carry it astride her hip precisely as do the cooly women of Hindostan; let him witness their human-like emotions of affection, satisfaction, pain, and childish rage,—let him see all this,

and then he may feel how much more potent has been the lesson than all he has read in pages of abstract ratiocination.

Prof. Alexander Graham Bell has presented a memoir to the National Academy on the formation of a deaf variety of the human race, in which he shows by tables a series of generations of certain families in which, the progenitors being deaf-mutes, this peculiarity becomes perpetuated in many of the descendants. Recognizing fully the laws of heredity, natural selection, etc., he shows that the establishment of deaf-mute schools, in which a visual language is taught which the pupils alone understand, tends to bring them into close association with each other; and that naturally, with this seclusion, acquaintance ripens into friendship and love, and that statistics show that there is now in process of being built up a deaf variety of man.

Dr. W. K. Brooks, animated by the cogency of Professor Bell's reasoning, is led to prepare an article entitled 'Can Man be Modified by Selection?' In this paper he discusses the startling proposition of Professor Bell, and recognizes the convincing proof which he furnishes to show that the law of selection does place within our reach a powerful influence for the improvement of our race. The striking character of the tables of facts presented by Professor Bell, and the significant suggestions of Dr. Brooks, lead one to consider how far the influence of selection has had to do with the character of great communities, as to their intelligence or ignorance. When we see nations of the same great race-stock, — one showing a high percentage of illiterates, a high death-rate, degradation and ignorance, while just across the borders another nation, apparently no better off so far as physical environments are concerned, with percentage of illiterates and death-rate low, intelligent and cleanly, — we are led to inquire if here a strict scientific scrutiny with careful historical investigation will not reveal the cause of these conditions. Can it be proved beyond question that the illiteracy and degradation of Italy and Spain, up to within recent years at least, is the result of centuries of Church oppression and the Inquisition, destroying at once, or driving out of the land, all independent thinkers, and at the same time forcing her priests to lead celibate lives, and inducing others of cultivated and gentle minds to lead cloister lives? Is it also a fact, as Alphonse de Candolle asserts, that by far the greater number of distinguished scientists have come from Protestant pastors? He gives a significant list of eminent men whose fathers were Protestant pastors, saying, that had they been priests of another religion, leading celibate lives, these men would not have been born.

It is considered an intrusion into matters which do not concern science when such inquiries are made, but the scientist has very deeply at heart the intellectual and moral welfare of the community. If the cause of degradation and ignorance, of poverty, of contagious disease, or of any of the miseries which make a nation wretched, can be pointed out by scientific methods, then it is the stern duty of science to step in and at least show the reasons, even if the remedy is not at once forthcoming. The men who would be reformers and agitators, and who by their earnestness and devotion get the attention of multitudes, are unfit for their work if they show their ignorance, as most of them do, of the doctrines of natural selection and derivation.

In drawing to a close this very imperfect summary of what American zoologists have accomplished for evolution, many other distinguished contributors might have been mentioned. The work of eminent physiologists and paleontologists has hardly been considered; nor has the long array of botanical facts for Darwin, as revealed in the fascinating study of the relations which exist between flowering plants and insects, contrivances for cross-fertilization, means of plant-dispersion, etc., and the distinguished botanists connected with this work, received attention here. Indeed, the proper limits for an address of this nature have been far exceeded.

Suffice it to say, that all these students have worked from the standpoint of derivative doctrines. A still greater triumph to Darwinism are the evidences of gradual conversion still going on among a few isolated workers who still remain stubborn, yet yielding to the pressure of these views by admitting features that ten years ago they repudiated.

There are two points to be emphasized here in closing: and one is, that American biological science stands as a unit for evolution; and the other is, the establishment of a great generalization which shows, that, when intelligence became a factor in animals, it was seized upon to the relative exclusion of other characteristics. This generalization offers an unassailable argument to-day for a wider, broader, and deeper education for the masses. The untold misery and suffering of the working-classes as witnessed in their struggles of the last two years would have been avoided had the rudiments of social science, even a knowledge of the value and significance of simple statistics, been appreciated by them.

The startling paper of Dr. Seaman (*Science*, viii. No. 190) on the social waste of a great city shows the blundering, criminal way in which municipalities are controlled by coteries ignorant alike of Science and the beneficent mission she stands waiting to enter upon.

#### PREHISTORIC CHRONOLOGY OF AMERICA.<sup>1</sup>

THE prehistoric period of America dates back from the discovery of the several parts of the continent; and the problem is to reconstruct the history of the various nations who inhabited both Americas in this period. A review of the means at our command to accomplish this, divides them into six classes: —

I. *Legendary*. — This includes the legends or traditions of the native tribes. These often bear a strong resemblance to Semitic or other Oriental myths, but the similarity is a coincidence only, and those writers have been led astray who count it for more. The annals of the Mexicans, the Mayas of Yucatan, and the Quichuas of Peru, carry us scarcely five hundred years before the voyage of Columbus, although the contrary is often stated. The more savage tribes practically remembered nothing more remote than a couple of centuries.

II. *Monumental*. — The most famous monuments are the stone buildings of Mexico, Yucatan, and Peru. By many these are assigned an antiquity of thousands of years; but a calm weighing of the testimony places them all well within our era, and most of them within a few centuries of the discovery. The celebrated remains of Tiahuanuco in Peru are no exception. Much more ancient are some of the artificial shell-heaps along the coast. They contain bones and shells of extinct species, in intimate connection with stone implements and pottery. They furnish data to prove that the land was inhabited several thousand years ago.

III. *Industrial*. — The industrial activity of man in America may be traced by the remains of his weapons, ornaments, and tools made of stone, bone, and shell. In most of the deposits examined, specimens of polished stone and pottery testify to a reasonably developed skill; but in the Trenton gravels and a few other localities, genuine palæolithic remains have been found, putting man in America at a date coeval with the close of the glacial age, if not earlier. The vast antiquity of the American race is further proved by the extensive dissemination of maize and tobacco, — tropical plants of southern Mexico, which were cultivated from the latitude of Canada to that of Patagonia.

IV. *Linguistic*. — It is believed that there are about two hundred radically different languages in North and South America. Such a confusion of tongues could only have arisen in hundreds of centuries. The study of these languages, and of the gradual growth of their dialects, supplies valuable data for the ancient history of the continent.

V. *Physical*. — The American race is as distinctively a race by itself as is the African or white race. Although varying in many points, it has a marked fixedness of ethnic anatomy, and always has had. The oldest American crania, collected from the most ancient quaternary deposits, are thoroughly American in type.

VI. *Geologic*. — As the discovery of implements in glacial deposits locates man on this continent at least at the close of the glacial epoch, this carries his residence here to about thirty-five thousand years ago. But there is no likelihood that he came into being on this continent. He could not have developed from any of the known fossil mammalia which dwelt here. More probably some colonies first migrated along the preglacial land-bridge which

<sup>1</sup> Abstract of an address before the Section of Anthropology of the American Association for the Advancement of Science, at New York, Aug. 10-17, 1887, by Dr. Daniel G. Brinton, vice-president and chairman of the section.

once connected northern America with western Europe. Later, others came from Asia. At that time the physical geography of the northern hemisphere was widely different from the present.

These various data have as yet been but imperfectly studied: when they shall have received the attention they merit, we may confidently calculate on a large increase in our knowledge of the course of events in ancient America.

#### ECONOMY IN MANAGEMENT OF SOIL.<sup>1</sup>

IN this great metropolis, or wherever our association meets, we are shown with pride the abounding evidences of the progress of a great nation, and the material prosperity of its people.

Tracing this visible wealth to its source, we find that it has all, with insignificant exceptions, been produced from the soil. The American inheritance was a fertile soil. A policy perhaps warranted by the circumstances, but none the less improvident, has marked the growth of the nation. Generation after generation has recklessly drawn upon the stored fertility of the land, with no systematic effort at restitution, not only to supply the current support of people, but the surplus which has provided all our apparent wealth and private improvements.

The rapidly increasing demands of our own country are met, and more than met, so far as mere quantity is concerned, for a great surplus is annually sent abroad. For twenty years agricultural products have constituted three-fourths of the total exports from the United States, while in single recent years this proportion has reached eighty-three per cent, and amounted in value to nearly nine hundred million dollars. And it is manifest that this superabundance of soil-products will continue, despite any possible increase in population, at least well into the next century. We boast of our great exportation of soil-products, forgetting that this really means the sending to foreign lands great blocks of our store of natural fertility, thus disposing of the main source of our material wealth by the ton and by the million. The steady reduction in the fertility of the soil, which results from the annual draught by cropping and the absolute loss incident to ordinary disposition of the crops, is much greater than commonly understood, and a matter so important as to demand serious consideration.

For present purposes it is sufficient to refer to only three elements of plant-food, which are of vital importance, and in which the soil is most likely to be, or to become, deficient. A computation based upon the mean annual agricultural products of the United States at the present time, the average composition of these products as far as known to chemistry, and the cash value of the chief fertilizing-materials in domestic markets, gives the following stated quantities and values of the three elements named, which are taken from the land by the farming operations of every year:—

|                                                       |                 |
|-------------------------------------------------------|-----------------|
| 4,000,000 tons of nitrogen, worth \$360 per ton.....  | \$1,440,000,000 |
| 3,000,000    "   potash,       100    "       .....   | 300,000,000     |
| 2,000,000    "   phosphoric acid, 120   "       ..... | 240,000,000     |
| Total value.....                                      | \$1,980,000,000 |

The effect upon the soil depends, of course, upon the disposition of the products embodying these enormous quantities and values. Fortunately, a very large part remain upon or are returned to the land, in the process of harvesting and preparing for market, and more in the form of water and residues incident to consumption.

On the other hand, there are vast absolute losses resulting from the well-known wastes of towns and cities, besides the portions actually sent to foreign countries. To exactly apportion the disposition made of these products, and hence of the fertilizing elements represented thereby, is impossible; but as to the latter, a rough approximation divides the total into three parts, respectively remaining on the land, returned to the soil, and wholly removed from it.

This country imports the agricultural products of other countries in considerable quantity, but in kind far less important to the question in hand than our exports.

The articles exported are largely of a character especially rich in plant-food. Making due allowances, therefore, I estimate the

<sup>1</sup> Abstract of an address before the Section of Economic Science and Statistics of the American Association for the Advancement of Science, at New York, Aug. 10-17, 1887, by Henry E. Alvord, C.E., of Amherst, Mass., vice-president of the section.

average exportations as representing thirteen per cent of the fertility value of our total products, and our absolute wastes at home at more than twenty per cent additional. Together these constitute a full third of the figures above given, or an annual removal from American soil, of nitrogen, potash, and phosphoric acid, worth, in the markets of this city to-day, more than six hundred million dollars. By our present system, or rather continued improvidence in the production of the necessities of life, we are thus diminishing, at this alarming rate, the original capital of our foundation industry.

When products are exported, mainly food, which are worth seven hundred million dollars on our shores, there is included plant-food, all needed at home, which we cannot replace for one-third of that sum.

This fertility never comes back. It goes to enrich other lands, or is washed into seas from which we do not ever get the fish and the carp. Those of us who are contending with impoverished soils are well placed to appreciate the sober subject of agricultural exhaustion, and are in duty bound to send an earnest word of warning to those who labor on newer lands. The researches of modern times have done much in establishing truths of practical value regarding the effect upon the fertility of the land, of the removal of different crops and products, and hence teaching us what should be consumed at home, and what may be profitably sold.

Thus, if ton after ton of farm-produce be removed from a Western farm to an Eastern market, or from any American farm to a European market, it makes a great difference eventually, to the land where produced, and to its owner or user, whether these tons be cotton or corn, beef or butter.

The following table illustrates this point:—

| Articles<br>of<br>Export.                | Mean Annual<br>Exports in<br>Tons. | Approximate<br>Value of 1 Ton<br>at Place of<br>Export. | Value of the<br>Plant-Food<br>in 1 Ton. | Percentage of<br>Plant-Food<br>Value on the<br>Market-Value<br>1 Ton. |
|------------------------------------------|------------------------------------|---------------------------------------------------------|-----------------------------------------|-----------------------------------------------------------------------|
| Cottonseed-meal... }                     | 250,000                            | \$ 26.00                                                | \$28.04                                 | 108.00%                                                               |
| All 'oil-cake' and<br>'oil-meals'..... } |                                    | 24.00                                                   | 23.80                                   | 100.00                                                                |
| Tobacco.....                             | 150,000                            | 200.00                                                  | 15.92                                   | 8.00                                                                  |
| Beeves alive.....                        | 100,000                            | 100.00                                                  | 13.98                                   | 14.00                                                                 |
| Dressed beef.....                        | 50,000                             | 160.00                                                  | 13.99                                   | 8.75                                                                  |
| Pork products.....                       | 500,000                            | 200.00                                                  | 13.43                                   | 6.25                                                                  |
| Wheat.....                               | 3,000,000                          | (34 bus.) 34.00                                         | 8.80                                    | 26.00                                                                 |
| Wheat-flour.....                         | 750,000                            | (10 bbls.) 50.00                                        | 7.08                                    | 14.00                                                                 |
| Corn (maize).....                        | 14,000,000                         | (36 bus.) 23.00                                         | 6.94                                    | 30.00                                                                 |
| Cotton.....                              | 1,000,000                          | (4 bales) 200.00                                        | .60                                     | -                                                                     |
| Butter.....                              | 15,000                             | (40 tubs) 400.00                                        | .52                                     | 0.13                                                                  |

It merely mitigates the evil presented, to note that the soil holds large quantities of plant-food still in store; that nature has provided supplies of mineral manures in concentrated form, deposited in various places; and that some investigators yet believe they will prove conclusively the assimilation by plants of the free nitrogen of the atmosphere.

Should this much-disputed question of nitrogen-supply be so settled, it would certainly remove a vast deal of anxiety, trouble, and expense; for, as we have seen, nitrogen constitutes three-fourths in value of the plant-food annually used by crops. But the prevalence of the belief that the growing plant depends almost exclusively upon the nitrates of the soil, and has no power to assimilate the free nitrogen of the air, is amply shown by the market-prices of ammoniated manures and the extent of their sale and use.

The trade in commercial fertilizers has reached wonderful proportions, and agriculturists hail with joy the discovery of every new deposit like the potash-salts of Germany and the mineral phosphates of Canada and the Carolinas. But the expense incident to mining, manipulation, and transportation, greatly impedes the use of these natural stores, and makes the more important every means of husbanding the home resources of every acre of valuable land. If the

statement could be accepted without much qualification, we might derive great comfort from the assurance that chemical examination of soils shows the presence, within reach of the plough, of nine thousand pounds of potash, and half as much phosphoric acid, on every acre, or enough to furnish the average crop for from two hundred and twenty-five to two hundred and fifty years.

Now, in the first place, the average land in tillage at the present time by no means reaches such a standard; and, in the second place, it is well known that but a very small fraction of the plant-food actually present in soil is in an available form. Ordinarily more than ninety-nine per cent of the plant-food found in soil by the chemist the plant itself finds dormant or unavailable. Time and natural agencies gradually convert their inert elements; but, to keep pace with agricultural demands, the physical properties of soils must be closely studied, and knowledge obtained and applied regarding the proper mechanical treatment of land. Figures already sufficiently demonstrate the recognized condition and needs of the soil. So difficult is it to make the once fertile land take back into use the natural resources, and so active the demand for plant-food in every available form to return to the soil, that, incredible as it appears, commercial fertilizers are maintained at such selling rates as to make the entire annual farm-products of this country worth half as much for manure as they are in market.

With our rapidly increasing population, and a constantly lessening fertility of soil, we have presented to us questions of the gravest import. By the wasteful processes prevailing, we are expending our very substance, and daily adding to a burden under which generations to come will stagger.

The true economy of soil management, involving the production for our people of food and clothing, fuel and shelter, and the wise management and disposition of our surplus, are problems great enough to satisfy the ambition of both scientists and statesmen.

In all expositions of the condition and prospects of the agriculture of this country, Gen. Francis A. Walker claims that the American people have been fully justified, upon sound economical principles, in the past system of cultivation of the soil at the expense of future generations.

"Thirty-eight noble States, in an indissoluble union, are the justification of this policy. Their school-houses and factories, their roads and bridges, their railways and warehouses, are the fruits of the characteristic agriculture of the past."

But the reason for wasteful systems no longer exists. "The country in the arable parts is settled, and the line of population now rests near the base of the great sterile mountains which occupy so large a portion of the continent. . . . A continuance of this policy will be, not the improvement of our patrimony, but the impoverishment of our posterity. . . . Economical and political considerations alike demand that the soil bequeathed to this generation, or opened up by its own exertions, shall hereafter be deemed and held as a sacred trust for the American people through all time to come, not to be diminished or impaired for the selfish enjoyment of its immediate possessors."

These considerations should increase our regard for and interest in the business of farming. We should all rejoice at the revival of agricultural studies, and the increasing number of able men who are making them their life's work.

Let me cordially invite continued contributions to the proceedings of this section, upon foods, fabrics, forestry, industrial education, and other topics closely related to our material welfare. And I appeal for more encouragement and aid for the earnest workers in other sections,—in biology and chemistry, physics and mechanics,—who are laboring in the various branches of science, that its practical results may be applied to economizing the fertility of the soil, which is the basis of our material prosperity.

#### MENTAL SCIENCE.

##### The Sense of Smell in Dogs.

DR. G. J. ROMANES, by his careful observations and happy generalizations, has made himself the representative of the growing science of comparative psychology. His two books on animal intelligence and on mental evolution in animals (to which is to be added a third on the mental evolution of man), written under the

inspiration of Darwin, have done more, perhaps, than the works of any other writer, to introduce scientific order into a field formerly given over to poorly described, exaggerated stories, and hasty, unwarranted generalizations. With the downfall of the anthropomorphic theory of the universe, the importance of the mental phenomena observable in animals was more readily recognized and appreciated. Hundreds of observations drawn up with the requisite details and accuracy have been collected, and a number of reliable and suggestive generalizations have been recorded. To these Dr. Romanes has added an important study on the method by which his dog follows the scent of the master.

The observations were made on Dr. Romanes' setter-bitch, an animal very much attached to him. They were made on the grounds adjoining his house, and a number of precautions not easily described were taken. (1) When Dr. Romanes walks over the ground with his hunting-boots on, the dog follows the scent with the greatest readiness. (2) If she is put to the track of a stranger, she pays no attention to it. (3) The dog was led into the room when preparations were going on for an outing, but, instead of Dr. Romanes going out, the gamekeeper (whose scent he follows next after that of Dr. Romanes) went: when set free, the animal at first followed the track, but, finding that her master was not with the gamekeeper, returned. (4) The next experiment was a very ingenious one. Twelve men walked in Indian file, so that they all trod the same footsteps, thus producing a conglomerate of olfactory impressions. Dr. Romanes headed the company, so that the traces of his steps should be most obliterated; and, after walking thus two hundred yards, the first six men walked in one direction, the last six in another. The dog quickly ran along the route followed by the twelve, overshot the point of division, but soon returned and followed the direction taken by the six headed by Dr. Romanes. (5) A number of experiments were made to ascertain what part of Dr. Romanes' person or of his apparel gave the clew to the animal. It was suspected to be the hunting-boots, and this proved correct. A stranger put on these boots, and the dog eagerly followed the scent; and, contrariwise, when (6) Dr. Romanes put on the stranger's boots, the animal was indifferent to his track. (7) Further experiments were made to locate the source of the scent in the boots. The dog did not follow the scent of a stranger walking in bare feet. (8) When Dr. Romanes walked in bare feet, the dog followed the trace, but less eagerly than usual, and with much hesitation. (9) Again, the animal did not follow Dr. Romanes when he put on new shooting-boots. (10) Next a single sheet of brown paper was glued to the soles of his usual hunting-boots. The dog did not catch the trail until he came to a place where, as Dr. Romanes had previously noted, a few square millimetres of the paper had come off. (11) When her master walked in new cotton socks, the trail was lazily followed, and soon given up. With woollen socks worn all day the result was the same. (12) Dr. Romanes next walked fifty yards in shooting-boots; then three hundred yards in his stocking-soles, carrying his boots; then three hundred yards in his bare feet. The animal caught the scent, and followed it unhesitatingly through the whole distance, though the trace left by stockings or bare feet alone was not sufficient to guide the animal. (13) The next test was a modification of the last. Dr. Romanes and a stranger entered a carriage and drove for several hundred yards. The former, in his hunting-boots, then alighted and walked fifty yards, whereupon he re-entered the carriage, and the stranger walked the next two hundred yards: the dog, when shown the track, ran the whole two hundred and fifty yards without pausing. The experiment was repeated with another stranger, with the same result. (14) To test the power which the dog had of selecting the distinctive odor accompanying her master from other odors, Dr. Romanes soaked his hunting-boots in anise-seed-oil. The odor was so strong that a friend could follow the track an hour later by the odor of the oil; yet the dog was not confused except that she hesitated about the first few steps, but then pursued as usual.

The next test was directed towards ascertaining whether the animal could distinguish her master by odors emanating from other portions of his person. (15) Dr. Romanes, after pursuing a zig-zag course just trodden over by a number of footsteps, hid behind a wall, with his eyes just visible. The animal went at once to the hiding-place. (16) Again he hid in a ditch, with only the top of



his head visible. At two hundred yards the dog detected her master, and went to him directly.

From these tests, Dr. Romanes concludes that the dog distinguishes him from all others by the odor of his boots (1-6), and does not distinguish him in his naked feet (8-11). The odor is probably emitted by the feet, but must be mixed with that of shoe-leather to be of service to the dog. This is doubtless a matter of education: had the dog been used to following her master when without shoes, the animal would have learned to follow him thus. The characteristic odor cannot penetrate a sheet of brown paper, but a few square millimetres of surface is sufficient to give the dog the clew. The animal is ready to be guided by inference as well as by perception, but the inference is instantaneous (12 and 13 as compared with 2, 8, and 11). Lastly, not only the feet (through the boots) but the whole body emits an odor that the dog can distinguish in a mass of others (15). This order is recognized at great distances to windward (15), or in calm weather in any direction (16): it is not overpowered by anise-seed-oil (14) or by the foot-prints of another (4).

THE TIME NECESSARY TO PERCEIVE COLD AND HEAT. — It is well known that a cold sensation reaches consciousness more rapidly than a sensation of warmth. Dr. Goldscheider of Berlin, whose researches on the hot and cold points of the skin have gained him a well-deserved reputation, has recently accurately measured the length of the time necessary to perceive these sensations. The observations were made on parts equally sensitive to heat and cold, and with intensities of heat and cold equally different from the temperature of the part. The time of contact was recorded electrically by means of a metallic button fixed to the skin. Contact with a cold point was felt on the face after 13.5, on the arm after 18, on the abdomen after 22, on the knee after 25, hundredths of a second. The sensation of a hot point was felt on the same surfaces after 19, 27, 62, and 79 hundredths of a second respectively. This great difference in time has an important theoretical bearing on the physiology of dermal sensations.

#### BOOK - REVIEWS.

*Geological History of Lake Lahontan, a Quaternary Lake of North-western Nevada.* (U.S. Geol. Surv., Monogr. XI.)  
By I. C. RUSSELL. Washington, Government. 4°.

THIS volume, and the companion monograph by Gilbert on Lake Bonneville, are undoubtedly among the most interesting, if not the most important, contributions hitherto made to the ancient geography of this continent. It must be admitted, however, that the wonderful changes in the aspect of the Great Basin, of which we find here the most conclusive evidence, are scarcely ancient in the geological sense, having been accomplished almost wholly since the close of the glacial epoch, and largely since the advent of man.

Lake Lahontan, situated mostly within the area now forming the State of Nevada, filled a depression along the western border of the Great Basin, at the base of the Sierra Nevada; while Lake Bonneville, embraced almost entirely in the present Territory of Utah, occupied a corresponding position on the east side of the Great Basin, at the foot of the Wasatch Mountains.

The hydrographic basins of these two water-bodies embraced the entire width of the Great Basin in latitude 41°. Lake Bonneville was 19,750 square miles in area, and had a maximum depth of about 1,000 feet. Lake Lahontan covered 8,422 square miles of surface, and in the deepest part, the present site of Pyramid Lake, was 866 feet in depth. The ancient lake of Utah overflowed northward, and cut down its channel of discharge 370 feet. The ancient lake of Nevada did not overflow. Each of these lakes had two high-water stages, separated by a time of desiccation. In the Lahontan basin, as in the Bonneville, the first great rise was preceded by a long period of desiccation, and was followed by a second dry epoch, during which the valleys of Nevada were even more completely desert than at present. During the second flood-stage, the lake rose higher than at the time of the first high water, and then evaporated to complete desiccation; for the present lakes of the basin (Pyramid, Winnemucca, etc.) are of comparatively recent date, and are nearly fresh, for the reason that the salts deposited

when the quaternary lake evaporated were buried or absorbed by the clays and marls that occupy the bottom of the basin.

As Lake Lahontan did not overflow, it became the receptacle for all the mineral matter supplied by tributary streams and springs, both in suspension and in solution. The former was deposited as lacustral sediments, and the latter as calcareous tufa, or formed desiccation products when the lake evaporated.

The introductory chapter contains a sketch of the Great Basin as the explorer finds it to-day. It stands in marked contrast in nearly all its scenic features with the remaining portions of the United States. The traveller in this region is no longer surrounded by the open, grassy parks and heavily timbered mountains of the Pacific slope, or by the rounded and flowing outlines of the forest-crowned Appalachians; and the scenery suggests nought of the boundless plains east of the Rocky Mountains or of the rich savannas of the Gulf States. He must compare it, rather, to the parched and desert areas of Arabia and the shores of the Dead Sea or the Caspian.

To the geographer the most striking characteristic of the country stretching eastward from the base of the Sierra Nevada to the Rocky Mountain system is that it is a region of interior drainage. For this reason it is known as the 'Great Basin.' No streams that rise within it carry their contributions to the ocean; and the climate is dry in the extreme, the average yearly precipitation not exceeding twelve or fifteen inches.

The area thus isolated from oceanic water-systems is 800 miles in length from north to south, and nearly 500 miles broad, and contains about 208,500 square miles. At the south the valleys of the Great Basin are low-lying, Death Valley and the Colorado Desert being depressed below the level of the sea; but at the north the valleys have a general elevation of from 4,000 to 5,000 feet, while the intervening mountain-ranges rise from 5,000 to 7,000 feet above them.

The mountains exhibit a type of structure not described before this region was explored, but now recognized by geologists as the 'Basin Range structure.' They are long, narrow ridges, usually bearing nearly north and south, steep upon one side, where the broken edges of the strata are exposed, but sloping on the other with a gentle angle conformable to the dip of the beds. They have been formed by the orographic tilting of blocks of the earth's crust, that are separated by profound faults, and they do not exhibit the anticlinal and synclinal structures commonly observed in mountains, but are monoclinical instead. The mountains are rugged and angular, usually unclothed by vegetation, and owe their marvelously rich colors to the rocks of which they are composed, especially the purple trachytes, the deep-colored rhyolites, and the many-hued volcanic tuffs so common in western Nevada, often rivalling the brilliant tints of the New England hills in autumn.

The valleys or plains separating the mountain-ranges, far from being fruitful, shady vales, with life-giving streams, are often absolute deserts, totally destitute of water, and treeless for many days' journey, the gray-green sagebrush alone giving character to the landscape. Many of them have playas in their lowest depressions (simple mud-plains left by the evaporation of former lakes) that are sometimes of vast extent. In the desert bordering Great Salt Lake on the west, and in the Black Rock Desert of northern Nevada, are tracts hundreds of square miles in area showing scarcely a trace of vegetation. In winter, portions of these areas are occupied by shallow lakes, but during the summer months they become so baked and hardened as scarcely to receive an impression from a horse's hoof, and so sun-cracked as to resemble tessellated pavements of cream-colored marble. Other portions of the valleys become incrustated to the depth of several inches with alkaline salts, which rise to the surface as an efflorescence, and give the appearance of drifting snow. The dry surface material of the deserts is sometimes blown about by the wind, saturating the air with alkaline particles, or is caught up by whirlwinds and carried to a great height, forming hollow columns of dust. These swaying and bending columns, often two or three thousand feet high, rising from the plains like pillars of smoke, form a characteristic feature of the deserts.

Chapter II., on the genesis of Lake Lahontan, contains a summary of the facts which show that the lake filled a compound

orographic basin, resulting from the tilting of faulted beds. The question of outlet is discussed in detail, the conclusion being that the lake did not overflow.

Chapter III. discusses the physiography of the Lahontan basin, describing in detail the valleys and mountains, and its lakes, rivers, and springs, and including numerous analyses of the waters from these three sources. Attention is given to the peculiar playas or broad mud-plains of the arid region of the Far West, as well as to the temporary lakes, called 'playa-lakes,' which frequently flood them.

The physical history of the ancient lake is fully and ably discussed in Chapter IV. Under the head of 'Shore Phenomena' we find detailed descriptions and illustrations of the terraces, bars, embankments, etc., that were formed about its shores. The highest of the ancient water-lines is named the 'Lahontan Beach;' and the most conspicuous terraces below this are the 'lithoid,' 'dendritic,' and 'thinolitic.' Each of these marks the upper limit of a variety of tufa, from which it derives its name.

Numerous sections are introduced to show the structure and relations of the mechanical sediments, which consist of two deposits of lacustral marls, separated by a heavy layer of current-bedded gravels; thus recording two lake periods and an intermediate low-water stage.

Chapter V., on the chemical history of the lake, is especially important. It includes, first, a general account of the chemistry of natural waters as they occur in streams, springs, lakes, oceans, and enclosed lakes or seas, followed by descriptions of the tufas precipitated from the water of Lake Lahontan, the salts precipitated when complete evaporation took place, the efflorescences now forming on the desiccated floor of the lake, and the salt-works of the region. As already indicated, the tufas present three main divisions. The lithoid tufa is a compact, stony variety, and is the oldest of the principal calcareous deposits that sheathe the interior of the basin. Thinolitic tufa is composed of crystals, and was formed in the ancient lake when it was greatly reduced by evaporation. The dendritic tufa has a branching or dendritic structure, whence its name, and it is the newest of the tufa formations.

Chapter VI. presents the life-history of the ancient lake as determined by the abundant molluscan remains and other fossils that have been found. The shells show that the lake was fresh throughout its higher stages. During the period when thinolite was formed, it seems to have been too concentrated to admit of the existence of molluscan life, as no fossils have been found in that deposit. A chipped implement discovered in the upper lacustral beds indicates that man inhabited the Far West during the last rise of Lake Lahontan.

Chapter VII. is a brief *résumé* of the preceding chapters; while Chapter VIII. is devoted to a discussion of the quaternary climate of the Great Basin, the periods of greatest lake-expansion being correlated with the two glacial epochs of the Sierra Nevada, and believed to indicate cold and moderately humid periods.

In Chapter IX. we have a summary of the evidence bearing on the determination of the geological age of the lake. The conclusion reached is that it existed during the quaternary, but was more recent than the date usually assigned for the close of the glacial epoch.

The tenth and concluding chapter contains an account of the orographic movements that have affected the Lahontan basin since the last high-water period, including a map showing all the post-Lahontan faults, some of which are marked by exceedingly fresh escarpments, and are evidently still in process of formation.

The illustrations are profuse and admirably executed, and Mr. Russell's style is throughout clear and graphic. Details are mainly kept in the background, or presented in tabular form; and it is probable that both in general interest and educational value this monograph is excelled by none of the publications of the Geological Survey.

*Elements of Geodesy.* By J. H. GORE. New York, Wiley. 8°.

THE present publication is a treatise on some geodetic operations, and intended to give the beginner a clear insight into the subject. It begins with a brief historical sketch of the various attempts to determine the figure of the earth. The former half of the book is

devoted to a description of the instruments and of the elementary operations and methods of plane geodesy, but the principal object of the author is to describe the methods of spheroidic and geoidic geodesy. The student who begins to study this important branch of geodesy will, or at least ought to, be conversant with the instruments applied by geodesists, with the theory of least squares, and with the calculation of triangulations, which are set forth at some length in the first part of the book. On the other hand, the beginner, who will find some valuable and practical hints in the chapters on base measurements and the field-work of triangulations, will miss a discussion of topographical methods and operations. The book would become far more useful for the beginner, who must study the simpler geodetic operations before beginning with the measurement of the figure of the earth, if a description of the methods and theories of topography were included in the plan. The development of each formula is very complete, and the results are given in the shape that the majority of writers have considered the best. Examples are given to illustrate the application of the formulæ. The student will find at the end of each chapter a list of books referring to the subject under discussion. F. B.

#### NOTES AND NEWS.

As we go to press we have obtained a copy of the opening remarks of Prof. S. P. Langley, president of the American Association. Professor Langley spoke as follows:—

MEMBERS OF THE ASSOCIATION,—While, for the main purpose of our coming here, we are all of one mind, some must remember a peculiar pleasure in their first attendance, when they came to these meetings as solitary workers in some subject for which they had met at home only indifference, and held themselves alone in, till here, with a glad surprise, they met others, too, caring for what they cared for, and found among strangers a truer fellowship of spirit than their own familiar friends had afforded. With such communities of purpose wherever two or three among us are gathered together, it is a happy thing that we cannot remain strangers; for doubtless, of the many here who have habitually breathed "the calm and still air of delightful studies," there are few but know by experience how hard it is for one coal to keep alight alone, and how especially good it is for the solitary workers to be brought at times into the warmth of companionship. To a great many of us, then, it may be counted as the very chiefest good of such an assembly as ours to-day, that here each meets some one with a kindred glow, and finds that interest and sympathy from his co-worker without which the scientific life would be but too cold. It is most fortunate, nevertheless, that our happy constitution as a body, not only of investigators in science, but of teachers and lovers of knowledge, brings those here in greatest numbers who disseminate as well as produce it, and who are skilled to recognize the value of the newly mined product when brought into this public exchange of ideas. We must admit here, that foolish ideas as well as wise ones are brought to this open mart, and that, in dealing with the variety of papers now presented for acceptance, it becomes almost as hard a task for us to shut out folly as to entertain wisdom; for, after all, who are we that judge, and how can we say "wisdom is in us to decide," when it is chiefly because we are ignorant that we are here? Probably the only rule is that taught by experience, that since art is long and life short, experience difficult and judgment uncertain, knowledge commonly advances best by such little steps, that one foot is not lifted till the other is securely planted on the solid ground of fact. On the whole, then, while we agree that some rare visitors have come to us over the "high *priori* road," do not let us welcome without scrutiny all those who would walk over it into this association's domain. At the same time, in view of our ignorance as to the real nature and causes of things, I would plead with those of you who are judges, for a large tolerance, even of what seem to be errors of speculation, *when* these are found in company with evidence of a faithful original study of facts; for we shall then have, at any rate, done our best not to turn away Truth, even if she has come to us in an unfamiliar dress. And now I can only congratulate this assembly of her followers on a meeting which opens so auspiciously, and express the hope, that whether in the new knowledge which we may take to the section-room or find there, or in the



social pleasures the gathering brings, this may fulfil its large opening promise of being a fruitful and happy season to us and to our association.

— Dr. E. Naumann, late director of the geological survey of Japan, has published an essay on the influence of the structure of the earth upon the phenomena of terrestrial magnetism. His researches in Japan show that the magnetical lines are to some extent influenced by the *fossa magna*, a great fault which crosses the islands in a direction south-east by north-west. By studying the direction of the magnetical lines in connection with the geological structure of other countries, the author comes to the conclusion, that, in the vicinity of faults and folds, the magnetical lines show remarkable irregularities, and that a connection exists between both phenomena. Recent researches by Ciro Christoni on the intensity of terrestrial magnetism in Italy (*Atti della R. Accademia dei Lincei*, 1887, p. 200) show irregularities of the magnetical elements in the eastern part of Venetia, on the western part of the coast of Liguria, and in Val Pelice. These places coincide with centres of seismic disturbances, and suggest a connection between geological and magnetical phenomena. It seems, however, that the available material is still too incomplete for a thorough study of the question at issue, the magnetical surveys not being of a sufficiently detailed character.

— Charles E. Putnam of Davenport, Io., died July 19.

— Those interested in Spiritualism will read with special interest Prof. Carvill Lewis's account of two sittings with the noted English medium, Englington. This medium is such a tower of faith to believers, and has deceived so many, that so glaring an exposure of his methods as Professor Lewis gives is especially valuable. The article is published in the Proceedings of the English Society for Psychical Research, May, 1887.

— The readers of *Science* know from our notes on the exploration of Africa how rapidly one discovery follows another, and that it is difficult to keep a map up to date. This fact has induced J. Perthes to publish a second edition of his large map of Africa in ten sheets (1:4,000,000). The student of the geography of Africa will find this map, which contains an enormous amount of detail, and which is in every respect up to the date of publication, a valuable help in his researches. The routes of explorers, the tribes with whom they came into contact, and the character of the land they traversed, are shown in the map; deserts, steppes, and regions with tropical vegetation, including savannas and woods, being distinguished by different colors. An important feature of the map, and one necessary for the critical study of geography, is the distinction between countries which are really explored and those which are known by report only; the former being written with heavy letters, the latter with light ones. The new edition, of which two sheets — Kongo and Abyssinia — have been published, contains so much new material, that the section 'Kongo' is practically a new map. The results of the journeys of Kapello and Ivens, Reichard, von François, Kund and Tappenbeck, Wolf, Büttner, Grenfell, Junker, and the observations of Captain Rouvier, have been used in constructing this sheet. The important results of these journeys were published in our map of Central Africa some time ago. The observations of Chavanne and other visitors of the Lower Kongo induced the author, H. Habenicht, to include that region in the zone of steppes occupying south-west Africa. In Section 6, 'Abyssinia,' the routes of Cecchi and Chiarini have been made use of, and — what will be welcome to most readers — Emin Pacha's province, his stations, and those of the Kongo Free State, have been marked by separate colors. The political boundaries have been corrected according to recent treaties and annexations.

#### LETTERS TO THE EDITOR.

\*.\* The attention of scientific men is called to the advantages of the correspondence columns of *SCIENCE* for placing promptly on record brief preliminary notices of their investigations. Twenty copies of the number containing his communication will be furnished free to any correspondent on request.

The editor will be glad to publish any queries consonant with the character of the journal.

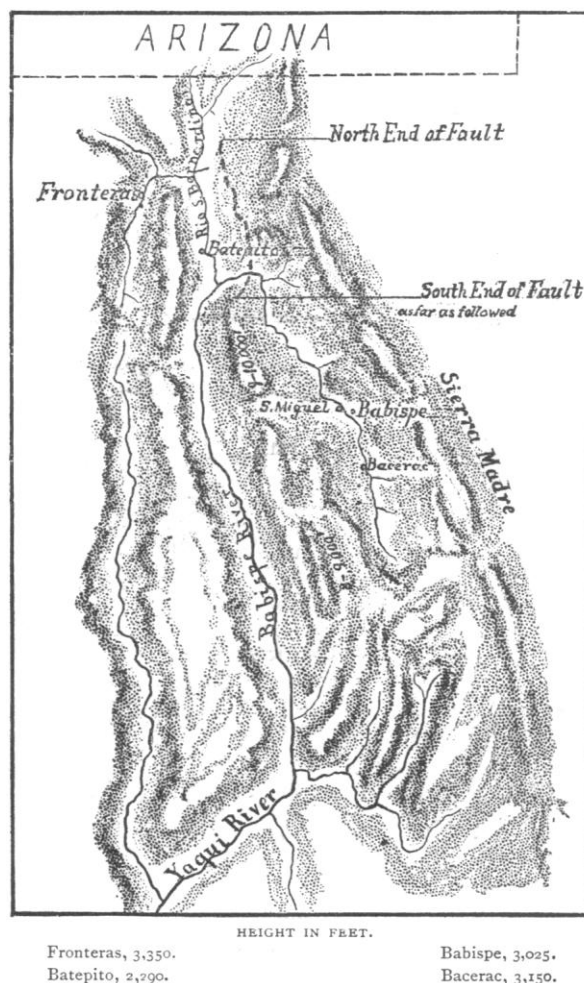
Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.

#### The Sonora Earthquake.

THE past month has been spent by me in Sonora, U.S. Mexico, in examining the scene of the greatest disturbances during the re-

cent earthquake of May 3. This trip has required mountain-travel of about seven hundred miles, horseback and on foot; fully one-half, the latter. While it is impossible now to give the complete results of my explorations, a brief summary may prove interesting.

There is not now, nor has there been, lava eruption or crater volcano. I visited every locality in the Sierra Madres where such phenomena had been reported — fruitlessly. There is a grand fault extending along the eastern side of the San Bernardino and Yaqui River valleys for nearly one hundred miles. This fault has a general northerly and southerly strike, with a dip of from 45° to vertical; and the difference in level of the two sides is for fifty miles an average of eight feet. It lies close to the foot of the mountain-ranges, where the *mesa* drift joins the steeper part of the chain, until it crosses the Yaqui, where it goes directly into the mountains. There are numerous minor faults and fissures; and



the entire valley of the San Bernardino is apparently sunk from two to four feet. The relative level is changed that much. This condition exists also on the Babispe River above and for some distance below Babispe, and on the Yaqui at and below its junction with the San Bernardino. Almost every water-course in the disturbed area has changed in the same way.

The town of Babispe was totally destroyed, forty-two lives lost out of a population of seven hundred. No other town in Sonora suffered much. Extensive evidence exists of irruption of water, sand, and fiery gases. As stated in my first letter, mountain-fires succeeded the first shock. These were caused by the ignited gases and falling boulders. Time data in Mexico, away from the railways, are unprocureable, none existing. The general fact that the first shock took place May 3, about 3 P.M., and that it came from a westerly direction, is all that can be obtained.

It is much to be lamented that the ground was not thoroughly explored before the beginning of the rainy season, which set in on the 14th of June with a violence unknown since 1881. This will

cause the obliteration not alone of the extensive and interesting minor details of the disturbance, but of many of the greater as well, particularly in the river-beds where the changes of level have occurred. The town of San Miguel, three miles north of Babispe, and Bacerac, nine miles south, were uninjured. This is, in view of the principal line of disturbance, particularly interesting.

I enclose a hasty tracing of the section, which may aid in showing the location of the fault. This does not show the length, for it is too tortuous. Scale of map is about 40 miles to the inch. The mountains as marked are the famed Sierra Madres.

G. E. GOODFELLOW.

Tombstone, Arizona, July 14.

#### Chemical Laboratory of the University of Nebraska.

So many requests for the plans and a description of the new chemical laboratory of the University of Nebraska have been re-

The entrances are in the south and north ends of the building; that in the south being the main one, while the north door is for the convenience of students coming to the laboratories from the other university buildings. Through this, access is had to every work-room in the laboratory, and to the main lecture-room on the second floor. This arrangement brings classes into the lecture-room from the rear,—an arrangement that will be appreciated by every lecturer on experimental science.

Entering at the south door, we find ourselves in the vestibule of the first floor. At our right and left, stairways lead to the basement floor, as shown in Fig. 3. Descending to the basement corridor (Fig. 2), at the front is a large vestibule opening by double side-doors into an area where heavy material is received. Under the stairway to our right is a small room containing the gas-meter. Under the left-hand stairway, and extending across the space occupied by the vestibule, is a ladies' toilet-room. Immediately in

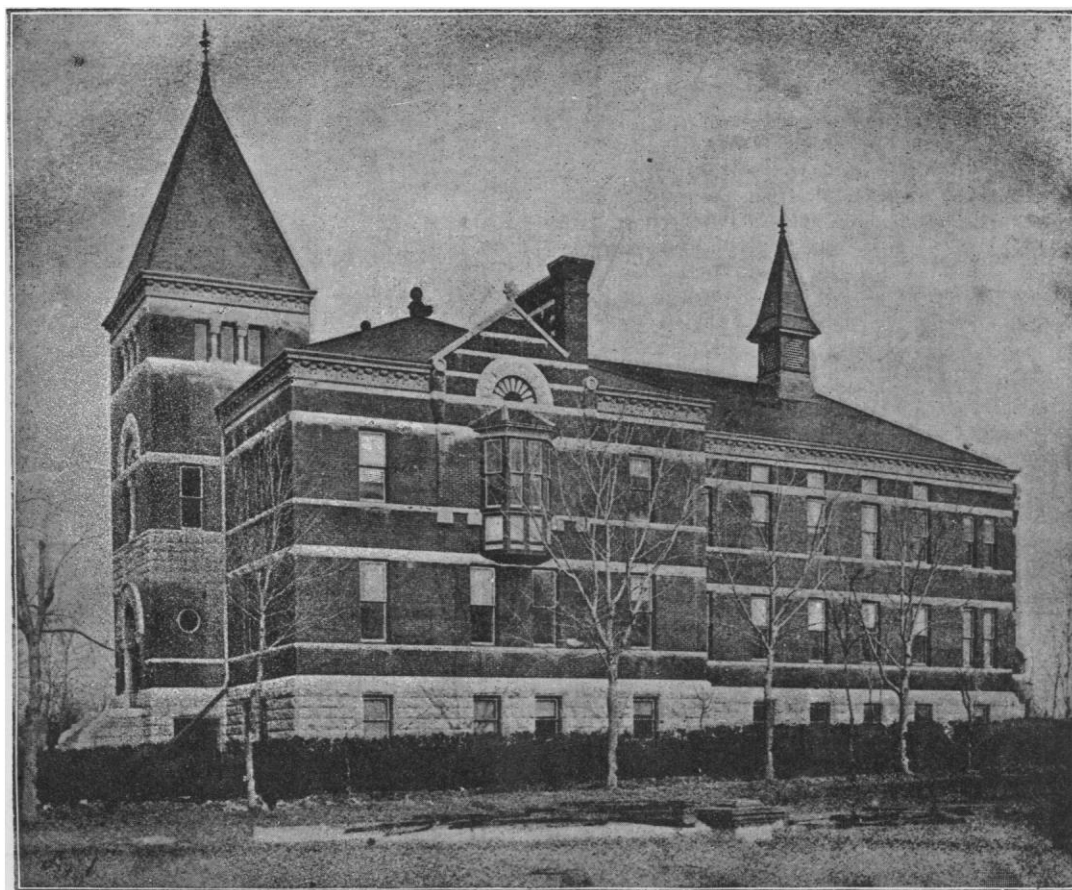


FIG. 1.

ceived since its erection, as to warrant the belief that a brief description of its general features would be of interest to the readers of *Science*, and especially to those who are contemplating the erection of similar buildings, or who are interested in the educational growth of the West.

The building is situated on the south-east corner of the university campus, fronting south on R Street. A wide street bounds the east side, while on the north and west is the open campus: thus the building commands an abundance of light from all directions.

Fig. 1 shows the south front and east side. The building consists of a high basement of native limestone, and a two-story superstructure of the finest St. Louis pressed brick, laid in black mortar and relieved by belt courses of rough limestone. The style of architecture is Romanesque, the broad and heavy stone arches and pointed towers giving to the whole an appearance of massiveness and solidity in keeping with its construction.

front of the stairway is the elevator shaft. The room at the right serves as a store-room for the basement laboratories, and as a balance-room for the assay and metallurgical laboratory. The corresponding room on the opposite side of the corridor contains a small upright boiler for furnishing distilled water, and large storage-tanks for hydrogen and oxygen gases. It serves also as a storage-room for acids and as a work-shop. The remaining portion of this floor is taken up by the general laboratory, where students beginning the study of chemistry do their work. This can be used as one large laboratory, accommodating seventy-five students at one time, or, by closing the communicating doors, be divided into two, A and B, A being used as an assay and metallurgical laboratory.

These rooms have high ceilings, and are well supplied with light. They are ventilated by means of the two large flues C and D, each of which is eight feet broad, and a series of smaller flues built into the side-walls, one between each pair of windows. The large

flues open directly into the air; the smaller ones, into the space under the roof, which communicates with the air by means of the small ventilating-tower on the rear part of the roof. On each floor, built into the space between the large flues, and opening into them, are large hoods accessible from both sides through sliding glass doors.

Extending along the side-walls—and this is the case in every laboratory-room in the building—is a table, furnished with gas and

for the use of those students who have had some preliminary training, and has accommodations for thirty-two workers. Opening from this laboratory at opposite corners are two rooms equal in size,—the one a balance and apparatus room; the other the private laboratory of the associate professor. Beyond these, on opposite sides of the south corridor, are a small lecture-room and a special laboratory. In this laboratory the chemical work of the investigations undertaken by the experiment-station will be carried on.

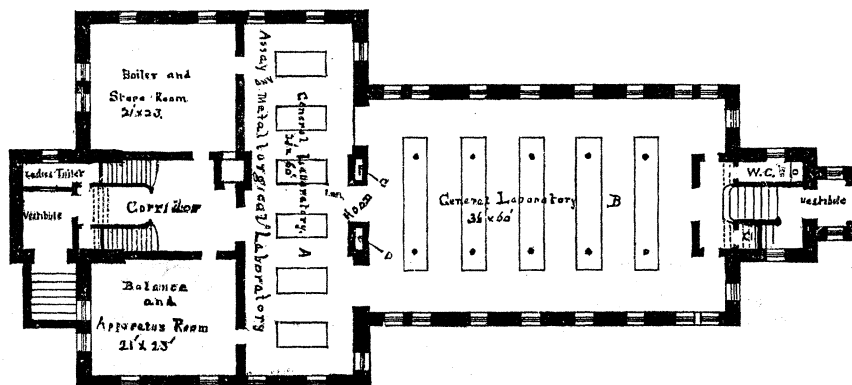


FIG. 2.

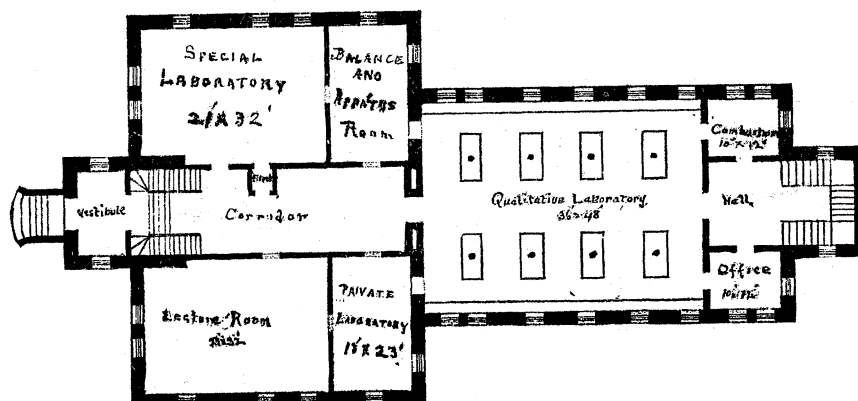


FIG. 3.

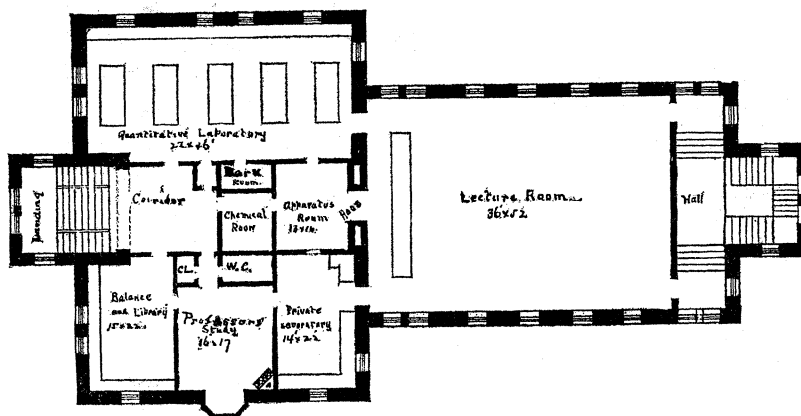


FIG. 4.

water, drawers and cupboards. These tables carry the smaller hoods, covering the sand and steam baths, and opening into the small flues. Space is also afforded here for such operations as require more room than the ordinary work-table gives.

Passing through the general laboratory, and ascending the stairway at the north end, we find ourselves in the north hall of the second floor (Fig. 3). On our right is a small room for blast-lamps and combustions. On the opposite side of the hall is the office and study of the associate professor of chemistry.

Passing on, we enter the qualitative laboratory. This is intended

Ascending the stairway at the end of the corridor, we reach the corridor of the second floor (Fig. 4). At our left is the quantitative laboratory, with accommodations for twenty students. Communicating with it is a small dark room for the storage of standard solutions.

Passing through the door in the north end of the room, we enter the main lecture-room. This room has a raised floor, placed at such a pitch that the top of the lecture-table can be seen from all parts of the room. It is furnished with Andrews's patent lecture-chair, and will comfortably seat two hundred people.

The lecture-table is large and roomy, and is abundantly supplied with water and gas. It is ventilated by powerful down draughts and movable box-hoods. Directly back of the table, and opening into the preparation-room, is one of the large hoods before mentioned. Connected with the preparation-room is a small dark room for the storage of chemicals. These rooms serve also as apparatus and store rooms for the laboratories on this floor.

Leaving the lecture-room from the opposite corner from which we entered, and passing through the laboratory and study of the professor of chemistry, we come to the balance-room and library. This room is very well supplied with books of reference and the current periodicals, having complete sets of the *Berichte, Fresenius Zeitschrift, Chemical News, American Chemical Journal, Centralblatt*, and others. No special room has been set apart for collections. It is the intention to utilize the corridors for this purpose.

The tables (Fig. 5) in each student work-room, except laboratory

accommodate ten students each. Besides table-supply, each laboratory has a large sink for use when large quantities of water are necessary. Distilled water is furnished on each floor. The building is heated throughout by steam from a central station in the main building. Fire-protection is afforded by sections of hose on each floor, connected with a standpipe which passes up through the centre of the building from basement to attic.

We have now been in occupancy about one year, and feel well satisfied with our arrangements, though some matters of detail await the necessary funds to carry them into effect.

H. H. NICHOLSON.

#### Answers.

11. LAKE ITASCA.—Rev. William T. Boutwell of Stillwater, Minn., several years ago, wrote for the Minnesota Historical Society the following account of the naming of Itasca Lake: "Coming to Mackinac in the summer of 1831, I received an invitation to spend the following

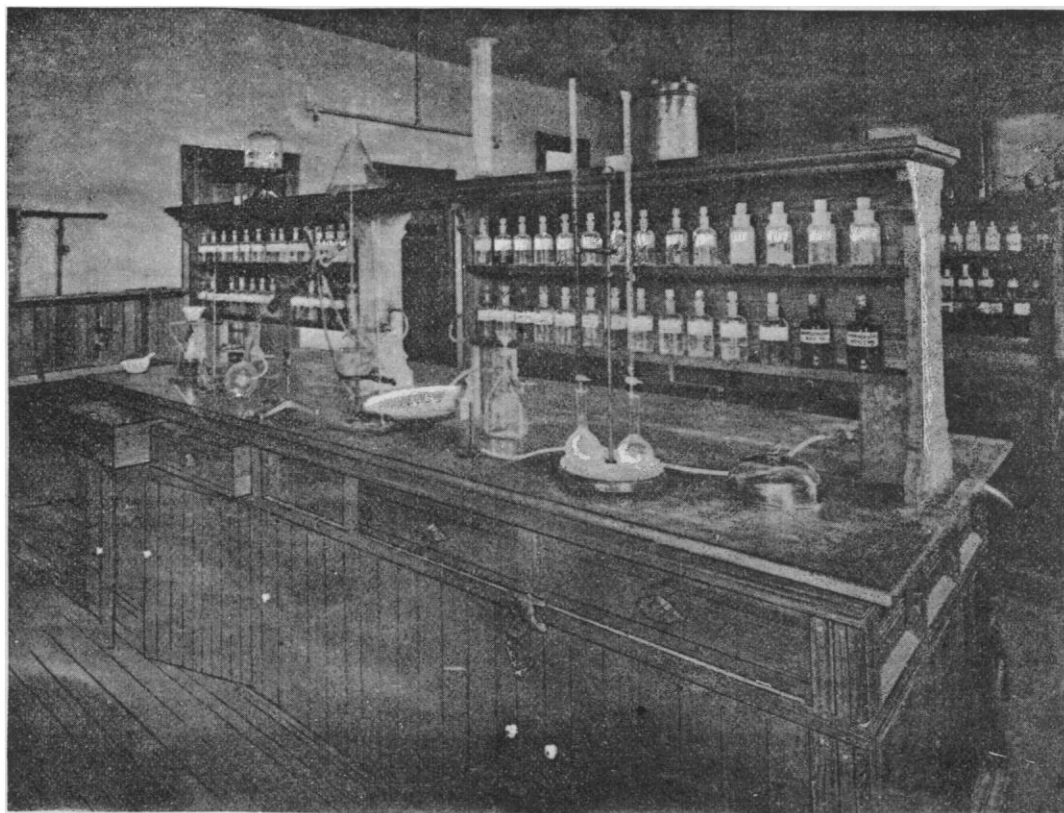


FIG. 5.

B, are ten feet long, four wide, and three feet and three inches high. Four students use one table; each having at his disposal, for storing his apparatus, two large drawers and two roomy cupboards, all secured by a single lock. Each student has two gas connections and an abundant supply of water.

The arrangement for water-supply is different from that usually employed. Instead of two basins placed at the ends, one large oval basin, twenty-one by sixteen inches, is sunk in the centre of the table, its long diameter across the table, and is supplied from two taps, one at each side. This arrangement has the advantages of being economical, convenient, and neat.

The work-places are numbered consecutively in each laboratory, and are supplied with sets of re-agent bottles, bearing, in enamelled letters, the name of the re-agent and the number of the desk. The stopper of the bottle bears a number corresponding to the one on its body. By this means a bottle out of place can be easily relocated, and the transposition of stoppers is inexcusable.

In laboratory B, tables are similarly equipped, and constructed on same general plan, except that they are twenty-six feet long and

winter at Sault Ste. Marie. There I made the acquaintance of Mr. Schoolcraft. Early in the spring of 1832, he received instructions from the government to visit the bands of Indians on the Upper Mississippi, and also to ascertain the true source of the river. He very kindly invited me to accompany him. Now for the origin or derivation of the name 'Itasca.' One morning we were coasting Lake Superior. Mr. S. said to me, 'I would like to give a name to Elk Lake that will be significant or expressive of the *head*, or *true source*, of the Mississippi. Can you give me any word in Latin or Greek that will convey the idea?' I replied, 'No one word will express the idea. The nearest I can come to it is *verum caput*, or, if you prefer the noun *veritas*, you may coin something that will meet your wishes.' In less than five minutes he replied, 'I have got the thing,' handing me a slip of paper on which was the word 'Itasca,' remarking, 'This is not poetic license, but you will find it, as you progress in the study of Ojibwa, to be Indian license. It was then and there, and in just this manner, that the name 'Itasca' was coined."

J. FLETCHER WILLIAMS.

St. Paul, Minn., Aug. 3.